Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

Conceivably, its color may at times serve to warn predatory foes, but the evidence herein adduced makes it clear that the pigmentation of *Chromodoris* plays no necessary rôle of this kind. We are consequently at liberty to infer that the conspicuous coloration did not develop, as the result of selection, according to the scheme proposed by the theory of warning coloration.

An illustrated account of this work will be submitted for publication later.

SOME EFFECTS OF THE CONTINUED ADMINISTRATION OF ALCOHOL TO THE DOMESTIC FOWL, WITH SPECIAL REFERENCE TO THE PROGENY

By Raymond Pearl

BIOLOGICAL LABORATORY, MAINE AGRICULTURAL EXPERIMENT STATION[1]

Read before the Academy, November 13, 1916. Received, November 13, 1916

1. In a recent number of these PROCEEDINGS there was presented[2] a summary statement of the results which had been obtained up to February 1, 1916, in a series of experiments designed to test the effect upon the progeny of the continued daily administration, by the inhalation method, of either ethyl alcohol, methyl alcohol, or ether to the parents, the domestic fowl being the form used in the work. The chief result was that the offspring of parents which had inhaled the vapor of one or another of the substances mentioned, for one hour each day over an average period of 210 days each, were measurably *superior* to the offspring of untreated parents in respect of the following characters or attributes: prenatal mortality, postnatal mortality at all ages, weight at hatching, adult weight, rate of growth, and percentage of abnormalities or defects of development. The offspring of untreated parents were superior to those of treated parents only in respect of their number; the untreated parents produced a larger total number.

It is the purpose of the present paper to report in brief and condensed, but numerical, form the results which have been obtained since the data at which the former report ended. The data included are those obtained in the breeding and rearing season of 1916. The length of the period over which the parents had been given daily treatments was of course longer by one year than in the 1915 breeding season. Thus the total germ dosage index[3] for the 1916 matings ranged from 458 to 1138, with a mean value of 562.9 days, for the parental generation, and from 0 to 266, with a mean of 40.6, for the grandparental generation.

Owing to various reasons, which cannot be gone into here, ether has been dropped from the list of experimental agents, ethyl and methyl alcohols alone being used now.

A detailed account of the experimental methods used and the precautions taken to ensure accuracy and trustworthiness of results is given in the complete reports now in press.

2. The general results of the 1916 matings, so far as concern the chief characters which may be taken as indices of vigor and vitality, are set forth in Table 1.

TABLE 1

SHOWING THE MORTALITY (PRENATAL AND POSTNATAL) OF CHICKS OF ALCOHOLIC ANCESTRY, AS COMPARED WITH THOSE OF NON-ALCOHOLIC ANCESTRY

Matings in 1916

NATURE OF ANCESTRY	NUMBER OF MATINGS	TOTAL EGGS SET	TOTAL ZYGOTES FORMED	ZYGOTES FORMED	PRENATAL MORTALITY	POST-NATAL (180 DAY) MORTALITY	ZYGOTES ALIVE AT 180 DAYS OF AGE
				per cent	*per cent*		*per cent*
Both parents alcoholic	5	82	18	21.95	11.11	25.00	66.67
Dam only alcoholic	3	63	5	7.94	80.00	0	20.00
Sire only alcoholic	13	512	274	53.52	47.08	13.79	45.62
Sire and one or more grandparents alcoholic	3	233	158	67.81	46.84	28.38	39.87
One or more grandparents alcoholic	3	187	113	60.43	46.02	6.56	50.44
All of alcoholic ancestry	27	1077	568	52.74	45.95	16.50	45.42
All of non-alcoholic ancestry	28	1333	1060	79.52	55.94	21.20	34.72
Differences	*1*	*256*	*492*	*26.78*	*9.99*	*4.70*	*10.70*
Alcoholic better = + Alcoholic poorer = −		−	−	−	+	+	+

From this table we note the following points:

a. Considering the totals, and comparing chicks with any alcoholic ancestry, as a group, with chicks having no alcoholic ancestry, as a group, it is clear that there are fewer of the former than of the latter from a given number of eggs. In every 100 eggs from birds in the alcoholic series approximately 53 zygotes (embryos) were formed as against 80 in every 100 eggs in the non-alcoholic series.

b. The total number of offspring zygotes dealt with in the experiments (1628) is respectable, and such as to lead to reasonable confidence in the results, especially in view of the fact that these results are in every essential particular in full accord as to their sense with those obtained in the 1915 experiments, and even more pronounced in degree.

c. The prenatal mortality is approximately 10%, and the postnatal mortality (to 180 days of age) is approximately 5% *lower* in the chicks with alcoholic ancestry than in those of non-alcoholic ancestry.

d. While from a given number of eggs 26.78% *fewer* zygotes are formed in the alcoholic series than in the non-alcoholic, 10.7% *more* of those zygotes are alive when adult age (180 days) is reached if their ancestry was alcoholic than if it was non-alcoholic.

e. The great reduction in zygote formation (partial sterility) observed in the alcohol treated series is preponderantly due to the effect of the alcohol upon the germ cells of the *female.* While there is some diminution in the effective fecundity of the male as a result of the treatment, it is much smaller than in the female. In the first two lines of the table, where the dam is alcoholic, we have 22 and 8% of the eggs forming embryos, as against values of from 54 to 68% where the sire is alcoholic and the dam not. The lower value for the percentage of zygote formation in the case of matings where the dam only is alcoholic as compared with those in which both parents are alcoholic, almost certainly does not represent a significant difference, but is an accidental result of the small number of matings in the class. The significant thing is the fact that the percentage of zygote formation steadily rises as we compare the following groups: (1) dam alone or dam and sire alcoholic, (2) sire alone or sire and some other ancestry not including the dam alcoholic, (3) no ancestry alcoholic.

3. In the season of 1916 every fertile egg in which the embryo died on or after the tenth day of incubation was opened, and an examination was made of the embryo in each case, in order to determine whether any structural abnormality or malformation was present. It was not found practicable to deal with embryos under ten days of age. A detailed record was kept of all such congenital abnormalities, in both the dead embryos and hatched chicks. Every discernible departure from perfect structural normality was taken account of, the range including at one extreme such slight and unimportant things as the congenital absence of one toenail in an otherwise perfectly normal chick, and at the other extreme acraniate and eyeless monsters. A later complete report will give the detailed data for the different classes of abnormalities. Here I wish simply to report the general results. These are set forth in Table 2.

TABLE 2

SHOWING THE NUMBER AND PROPORTION OF CONGENITAL ABNORMALITIES AND MALFORMATIONS FOUND AMONG THE CHICKS OF ALCOHOLIC AND NON-ALCOHOLIC ANCESTRY IN THE SEASON OF 1916

OFFSPRING OF	NO. OF MATINGS	MEAN GERMINAL DOSAGE INDEX		DEAD IN SHELL AFTER THE TENTH DAY OF INCUBATION		ABNORMAL KILLED AT HATCH	HATCHED CHICKS		TOTAL ZYGOTES SURVIVING TO THE TENTH DAY OF INCUBATION AND BEYOND	TOTAL ABNORMAL	PER CENT ABNORMAL
		P.	G. P.	Normal	Abnormal		Normal	Abnormal			
Treated parents or grandparents or both...........	27	562.9	40.6	78	19	4	267	20	397	43	*10.8*
Untreated control parents.....	28	0	0	190	23	14	372	42	641	65	*10.2*

From this table the following points should be noted:

a. The apparent discrepancy between Tables 2 and 1 in the figures for total zygotes arises from the fact that in Table 2 account is taken only of zygotes which survived for 10 or more days after fertilization. Out of a total of 568 zygotes formed in the alcoholic ancestry series 171 died before the tenth day of incubation.

b. The proportionate number of abnormalities of development is substantially identical in both series, amounting to about 10% of all zygotes formed. If this seems a high proportion let it be remembered that the category of abnormality is here very broadly defined and includes a number of developmental deviations which in no way reduce the survival value of the individual possessing them.

c. It is entirely certain that in these experiments there was *no significantly higher proportion of abnormalities of development among the zygotes of alcoholic ancestry than among those of non-alcoholic ancestry.* This result is in striking contrast to those which have been reported by Stockard,[4] and would appear to indicate a rather fundamental difference between guinea-pig and fowl germ plasms in respect of their susceptibility to alteration by alcohol.

d. While lack of space prevents the presentation of the detailed evidence here, it may be stated that an analysis of the data shows that the average relative gravity or intensity of the 10.8% of developmental abnormalities observed among the zygotes of alcoholic ancestry is probably not significantly different from that of the 10.2% in the non-alcoholic series.

4. It has been suggested in objection to all experiments where alcohol is administered by the inhalation method used by Stockard, MacDowell, the present writer, and others, that the animal gets no ap-

preciable amount of alcohol into the system. In view of all the facts this position is an extraordinary naive one and could only be held by one who had had no experience with the administration of alcohol by the inhalation method. It is true that it is practically impossible to induce by the inhalation method in animals habituated to alcohol that state of muscular incoördination which is usually, but by no means always, the most striking objective symptom of the condition of being drunk. On the other hand, it is extremely easy to kill an animal with ethyl or methyl alcohol administered by the inhalation method, quite regardless of whether it is or is not habituated to the substance. If the animal 'gets no appreciable amount of alcohol in its system' in the course of one hour's sojourn in a tank containing alcohol vapor it is extraordinarily difficult to understand how it manages to accumulate a fatally toxic dose of alcohol by staying in the same tank under the same conditions for from 20 minutes to half an hour longer. This is not only true for my fowls, for which the above time relations hold, but also, with other time relations, for mammals, as lately shown by Tyson and Schoenberg[5] in the case of methyl alcohol. Thirty-eight years ago Poincaré[6] demonstrated extensive and grave lesions in animals subjected to the continuous inhalation of methyl alcohol vapor.

It appears to be impossible, in the present development of the technique, to state the exact dosage per kilogram of body weight of alcohol administered by the inhalation method. I am now working on an indirect method of measuring the dosage, logically based upon the same reasoning as is used in the so-called 'physiological assay' of drugs.. As a first contribution in this direction I wish to present some data regarding the immediate physiological effect of the administration of ethyl and methyl alcohol to fowls thoroughly habituated to these substances. These observations have to do with respiration rate (respirations per minute) and rectal temperature (in degrees Fahrenheit). They are set forth in Table 3. Owing to lack of space this table gives mean values only, observations will be reported in a complete paper later. The means undoubtedly understate the true differences between the different groups because they include all the observations, some of which were made on cold days and before the apparatus for maintaining a constant temperature for the evaporation of the alcohol had been perfected. On such days the dosages, and in consequence the physiological differences, were reduced. By 'tanked controls' in the second line is meant birds which were put for one hour in a tank precisely like the alcohol tanks, but in which there was no alcohol or alcohol vapor.

TABLE 3

SHOWING THE EFFECT OF THE INHALATION OF ETHYL AND METHYL ALCOHOL VAPOR ON THE TEMPERATURE AND RESPIRATION OF FOWLS HABITUATED TO THESE SUBSTANCES

GROUP AND TREATMENT	RECTAL TEMPERATURE BEFORE TREATMENT F°	RECTAL TEMPERATURE AFTER TREATMENT F°	DIFFERENCE	RESPIRATION PER MINUTE BEFORE TREATMENT	RESPIRATION PER MINUTE AFTER TREATMENT	DIFFERENCE	NUMBER OF BIRDS IN GROUP	NUMBER OF OBSERVATIONS
Mean of normal controls...... ..	107.14			23.77			12	48
Mean of tanked controls........	107.07	107.13	*+0.05*	22.89	23.67	*+0.66*	4	16
Mean of all ethyls.............	107.07	106.43	*−0.64*	18.24	27.86	*+9.62*	7	29
Mean of ethyl ♀ ♀............	107.00	106.36	*−0.64*	18.24	28.76	*+10.52*	6	25
Mean of all methyls............	107.14	105.91	*−1.23*	18.56	22.50	*+4.31*	4	16
Mean of methyl ♀ ♀......	107.53	106.45	*−1.08*	19.00	23.75	*+4.75*	3	12

This table shows that:

a. Those birds which, by long continued daily treatment, extending over periods varying from six months to two years, have become thoroughly habituated to alcohol have a *slower respiration rate* than normal untreated birds of the same breeds, the difference amounting on the average to 4 or 5 respirations per minute. There appears to be no steady constant difference between chronic alcoholists and normals in body temperature.

b. The tanked control birds show no significant change in temperature or respiration as a result of an hour's sojourn in an empty tank.

c. On the contrary the birds which stay one hour daily in a tank containing alcohol vapor exhibit marked and definite changes in their physiological condition at the end of the hour. These changes consist of a *drop in temperature*, amounting on the average to nearly 1¼°F. in the case of methyl treatment, and about half as much in the case of ethyl, and a coincident *increase in respiration rate*, amounting on the average to about ten respirations per minute, or a 50% increase in the ethyl, and to about four and one-half respirations, or a 25% increase in the methyl.

d. These immediate physiological changes are precisely the same in kind and comparable in amount to those which have been shown by Völtz and Baudrexel[7] to follow the taking of moderate to large doses of ethyl alcohol by drinking, in the case of dogs and men.

5. I have interpreted the results on parental alcoholism which have been obtained by myself and other workers as due to a selective action of the agent upon the germ cells, in the sense of killing, or at any rate

inactivating, the weak germ cells and permitting only the strong, vigorous, and resistant germ cells to form zygotes. This results, in forms like the fowl having germ cells rather highly resistant to alcohol, in a small but superior progeny from alcoholists. On the other hand, in forms like the guinea-pig, whose germ cells are known to have a relatively low resistance to alcohol[8] it results in the formation not only of a relatively small progeny, but also a weak and abnormal one, since the germ cells which are not entirely inactivated by the agent are still not sufficiently resistant to be uninjured by it.

A rather striking confirmation of this interpretation was obtained in an experiment carried out this past summer. I reasoned that if the above interpretation is correct, alcohol ought to act as a selective agent in the same sense on the very young zygotes, killing the weak and permitting the survival only of the strong provided the appropriate dosage could be found. To test this idea the following experiment was performed. Two incubators were used, each containing at the outstart 390 eggs. These eggs were selected with the utmost care to ensure likeness of age, of strain, and of other characteristics in the two lots. In one incubator 40 cc. of 95% ethyl alcohol were evaporated beneath the eggs daily. In the other incubator no alcohol was used. At the end of 7 days 130 eggs, designated as Lot 1, were removed from the alcohol incubator and allowed to complete their development in a normal non-alcoholic incubator. At the end of fourteen days the remaining eggs (after testing out infertiles) of Lot 2, which originally contained 130 eggs, were removed from the alcohol incubator and finished their development without further dosage of alcohol in a normal incubator. Finally Lot 3, originally containing 130 eggs, was subjected throughout the 21 days of incubation to the daily dosage of alcohol fumes. At hatching all the normal chicks from both incubators were put together in the same house and brooder and given throughout life the same treatment as to feed, etc. Careful account was kept of mortality, each chick, being marked so that it could be told from which lot it came. The conditions of brooding were purposely made bad so to obtain a maximum severity of post-embryonic environmental conditions with a consequent high absolute mortality rate. The results are set forth in Table 4.

TABLE 4

DATA ON HATCHING AND MORTALITY OF CHICKS FROM ALCOHOL TREATED EGGS

Eggs set May 15. Hatched June 5

CHARACTER	LOT 1	LOT 2	LOT 3	CONTROLS
	Alcohol 1 week	Alcohol 2 weeks	Alcohol 3 weeks	No alcohol
Eggs set	130	130	130*	390
Eggs infertile	34	35	41	111
% infertile	*26.2*	*26.9*	*32.3*	*28.5*
All prenatal deaths	41	41	52	108
% of fertile eggs	*42.7*	*43.2*	*60.5*	*38.7*
Number good chicks in brooder	53	52	32	138
Dead in first 30 days	15	11	12	47
% chicks in brooder	*28.3*	*21.2*	*37.5*	*34.1*

* Three eggs were broken during incubation from this lot.

From this table we note the following points:

a. The original sorting of the eggs in the different lots was very fair and equal as is indicated by the nearly equal percentages of infertility.

b. The prenatal mortality was *higher* in all treated lots than in the controls, the differences ranging from 4% to 21.8%.

c. The postnatal mortality was *lower* in Lots 1 and 2, where the eggs had been alcohol treated for one and two weeks of incubation respectively. The decrease in postnatal mortality in Lot 2 amounted to 12.9%.

d. In Lot 3 the dosage was evidently too severe and the chicks which hatched had been injured by the treatment during incubation, with the result that they showed a somewhat higher postnatal mortality than the controls.

e. Synthesizing the results we may say that the more alcohol the embryos received during incubation the higher was the prenatal mortality, but until the dosage became so prolonged as to injure *all* the zygotes, as in Lot 3, the prenatal mortality was *selective*, since the higher the prenatal death rate the lower was the postnatal mortality among the hatched chicks.

f. The general result set forth in the preceding paragraph is contrary to the usual experience of poultrymen with ordinary untreated eggs, which is that if a lot of eggs hatch badly, many dying during incubation, a relatively high postnatal mortality among the chicks is also to be expected. It is believed that the present results may have an important practical application in the poultry industry.

In summary it may be said that the results during the 1916 breeding season confirm and extend the earlier results regarding the effects of parental alcoholism on the progeny in poultry. The additional data make still more certain the conclusions, first, that the progeny of alcoholized parentage (in poultry) while fewer in numbers is made up of individuals superior in physiological vigor, and, second, that this result is due to a selective action of the alcohol upon the germ cells.

---

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 105.

[2] Pearl, R., *Proc. Nat. Acad. Sci.*, 2, 380–384 (1916). *Cf.* also for a fuller statement of the results *Proc. Amer. Phil. Soc.*, 55, 243–258 (1916). The complete report on the earlier stages of the work is in press in *J. Exper. Zool.*

[3] This term is defined in my former papers as "the total number of days during which the two gametes making the offspring zygote have been exposed to alcoholic influence while sojourning in the body of the treated individuals."

[4] For summary and bibliography of earlier papers see Stockard, C. R., and Papanicolaou, G., A further analysis of the heredity transmission of degeneracy and deformities by the descendants of alcoholized mammals, *Amer. Nat.*, 50, 65–88, 144–177 (1916).

[5] Tyson, H. H., and Schoenberg, M. J., Experimental researches in methyl alcohol inhalation, *J. Amer. Med. Assoc.*, 63, 915–922 (1914).

[6] Poincaré, L., Sur les dangers de l'emploi de l'alcool methylique dans l'industrie, *Paris, C. R. Acad. Sci.*, 87, 682–683 (1878).

[7] Cf. for example Völtz, W., and Baudrexel, A., Ueber die vom tierischen Organismus unter verschiedenen Bedingungen ausgeschiedenen Alkoholmengen. II. Mitth., *Pflügers Arch.*, 142, 47–88 (1911); and other papers in the same series. Also note similar data in Völtz, W., Förster, R., and Baudrexel, A., Ueber die Verwertung des Bierextraktes und des Bieres im menschlichen und tierischen Organismus. *Ibid.*, 134, 133–258 (1910).

[8] Cf. Ivanov, J., Action de l'alcool sur les spermatozoïdes des mammifères (Première communication), *C. R. Soc. Biol., Paris*, 74, 480–482 (1913).

AN IONIZATION MANOMETER

By O. E. Buckley

RESEARCH LABORATORY, AMERICAN TELEPHONE AND TELEGRAPH COMPANY AND WESTERN ELECTRIC COMPANY

Received by the Academy, November 13, 1916

Heretofore the only manometers available for measuring extreme vacua have been the Knudsen manometer and the Langmuir molecular gauge. Both of these have serious disadvantages due to their delicate construction and slowness of action. A new manometer free from these objections and with a greater range of presssure than either has been developed. This manometer makes use of the ionization of gas by an electron discharge.

The manometer consists of three electrodes sealed in a glass bulb which serve as cathode, anode, and collector of positive ions. The cathode may be any source of pure electron discharge such as a Wehnelt cathode or a heated tungsten or other metallic filament. The exact forms of the electrodes are not of great importance. The collector is